REPORT DOCUMENTATION PAGE

Form Approved OMB No. 074-0188

1. AGENCY USE ONLY (Leave blank)

2. REPORT DATE
July 1993

3. REPORT TYPE AND DATES COVERED
Magazine

4. TITLE AND SUBTITLE
Gateway: Volume IV Number 2

5. FUNDING NUMBERS
SPO900-94-D-0001

6. AUTHOR(S)
Julien M. Christensen
David D. Woods
Joe Galushka
David Matson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Human Systems IAC
2261 Monahan Way, Bldg. 196
WPAFB OH> 45433-7022

8. PERFORMING ORGANIZATION REPORT NUMBER
GWIV2

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Defense Technical Information Cntr.
DTIC/AI
Cameron Station
Alexandria, VA 22304-6145

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.
Free to public by contacting the Human Systems IAC.

12b. DISTRIBUTION CODE
A

13. ABSTRACT *(Maximum 200 Words)*

This issue contains articles on the following subjects:1.Forensic Human Fators Psychology-Part 1; 2.Clumsy Automation, Practitioner Tailoring, and System Disaster; 3.The U.S. Army Safety Center and Human Factors; 4.Chronic Motion Sickness Treated with Cognitive-Behavioral Training; 5.Cardiorespiratory Measures and Their Role in Studies of Performance

14. SUBJECT TERMS
Human Behavior Human Factors Psychology Automation Situational Awareness US Army Motion Sickness Behavioral Training

15. NUMBER OF PAGES
20

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

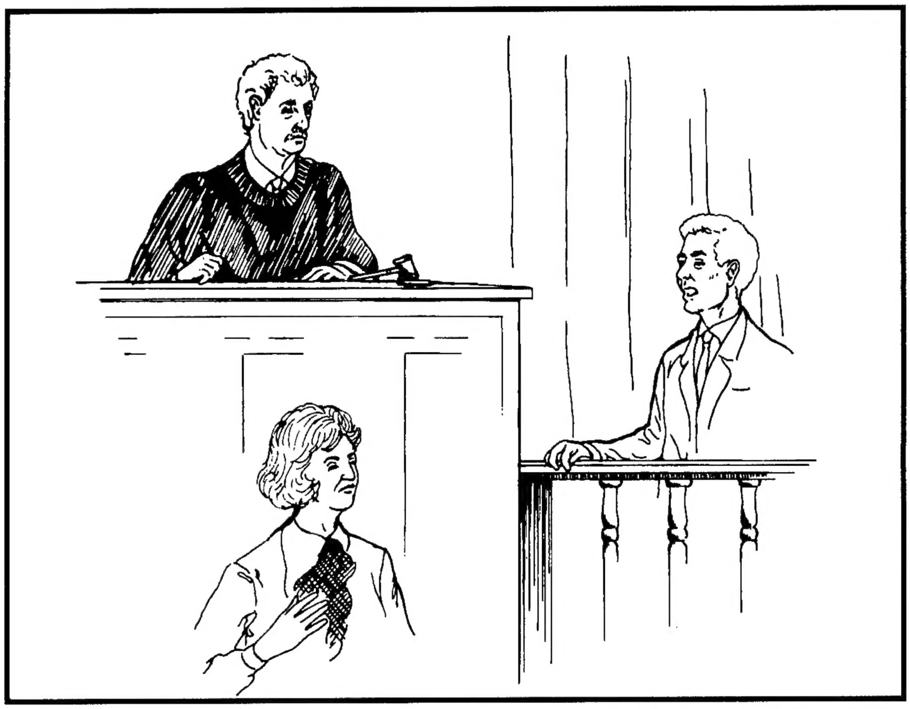
VOLUME IV: NUMBER 2 (1993)

CSERIAC GATEWAY

PUBLISHED BY THE CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

In this issue:

CSERIAC is a United States Department of Defense Information Analysis Center administered by the Defense Technical Information Center, Alexandria, VA, managed by the Armstrong Laboratory, Wright-Patterson Air Force Base, OH, and operated by the University of Dayton Research Institute, Dayton, OH.



In a court of law, the human factors expert can provide information that otherwise would not be available; however, the human factors expert must avoid the temptation to become an advocate. Illustration by Ronald T. Acklin.

Forensic Human Factors Psychology - Part 1

Julien M. Christensen[1]

Editor's Note: This is the first part of a two-part feature article. The second part will follow in the next issue of Gateway, Vol. IV, No. 3. JAL

Advancements in science and engineering have resulted in technological changes in the past 200 years that surpass those of the entire previous history of mankind[2]. When one considers some of these developments — the steam engine, the reaper, the cotton gin, the automobile, the airplane, the space ship, the computer, and on and on — it is evident that technological development has passed from an evolutionary stage to a revolutionary stage. However, fundamental changes in human beings are still proceeding at an evolutionary pace. Human senses, for example, are probably no more acute than they were 200,000 years ago. (Some, smell for example, may even have retrogressed.) This fact — revolutionary technological change versus evolutionary human change — has frequently caused mankind considerable pain. Consider, for example, the automobile. Estimates from the National Highway Traffic Safety Administration suggest that by the time

Continued on page 2

the automobile is 100 years old (approximately year 2000), 3,000,000 people will have died in this country as a result of traffic accidents. Statistics from the Occupational Safety and Health Association (OSHA) reveal that approximately 14,000 individuals are killed each year producing technological abundance for the rest (McElroy, 1974). Approximately another 30,000 are killed in American homes each year (Philo et al., 1975)[3]. Tragically, an undue proportion of the latter are the very young who will never experience life in any society, and the very old for whom surprisingly little has been done to make their few final years safe from the ravages of improperly designed artifacts.

Since human behavior is a function of heredity and environment, it would seem that those responsible for the human-made elements of the environment have a special responsibility to ensure that those elements are as free of hazards as possible. Tires should be as blow-out proof as it is possible to make them; hand railings on stairs should be substantial and held firmly in place; toys should entertain and educate, not maim and kill.

It is not unfair to observe, however, that many who design and manufacture products have a rather limited knowledge of the capabilities and limitations of those who will use their products. Most universities and colleges have been slow to include human factors courses in their engineering and design curricula (Christensen, 1977). Instead of enlisting the services of a human factors specialist, the typical designer uses the model of human behavior that is most readily available to himself or herself. However, in terms of technical knowledge, experience, motivation, and attitude, designers generally are not representative of those who will use their products. As a result, the products that are placed in the stream of commerce frequently are quite incompatible with the knowledge, habits, training, and expectations of the users. These incompatibilities frequently lead to accidents.

These accidents lead to lawsuits in which more and more frequently the central issues revolve around the suitability of the products for those who use them — design for human use, as it is frequently expressed. Attorneys, recognizing this fact, are turning more and more to human factors specialists who have training and experience in the behavioral and biological sciences for assistance in determining whether or not those who design, manufacture, and distribute products that are involved in accidents should be held liable for the injuries, deaths, and pain and suffering that result from those accidents.

The human factors psychologist has knowledge and methods with which he can often assist an attorney in a products liability case. Frequently, the psychologist will serve as a member of a team. The captain of the team, of course, is the attorney who may ask the psychologist to work with other experts such as engineers, materials specialists, physicians, and others. These interactions, if properly orchestrated by the captain, can be very productive.

The human factors psychologist must determine how the product was designed, manufactured, and distributed. Was it a systematic process with suitable attention given to safety considerations from the very beginning of the design process or was safety an afterthought? Did the manufacturer test the product on a representative sample of users under representative conditions of use? (This is one of the most common flaws in a products-development program. Instead of soliciting opinions and actions from typical users, many designers will settle for the opinions of those in their peer groups.) Did the manufacturer have a plan for following the product into the field to obtain additional information on improvements that could be made from the safety standpoint? And so on. The point is, however, that the design, manufacture, and distribution of products in a technological society must be systematic, well planned, and carefully executed, with attention given early and throughout the process to how humans will interact with those products. The human factors psychologist, with his knowledge of human capabilities and limitations, is in a preferred position to work with engineers and other designers who want to develop safe, effective products.

The human factors psychologist can also be of considerable assistance in the identification and assessment of hazards, risk, and danger[4]. Incompatibilities with human capabilities can be identified. The results of such inquiries can serve as a basis for items in the interrogatories that the attorney prepares and as supporting information with respect to other aspects of his case planning.

If the attorney feels that there is, indeed, a human factors issue that is even tangentially relevant, the human factors psychologist probably will be deposed. The attorney must help the expert prepare for this event which, for the expert, is often an unusual, stressful experience. The expert must become completely familiar with the product, with where and how it was designed, manufactured, and distributed, as well as with where and how it was being used at the time of the accident. The best advice that I ever received with respect to both depositions and trial testimony consisted of only three words: "Tell the truth!" Not that an expert would intentionally lie, but, because the court has accepted him as an expert, he may feel (and opposing attorneys often will encourage this feeling on his part) that he should be able to answer any and all questions in his field of expertise. Not so! The true expert knows that there are always points or details with which he is not familiar at the moment and he will not hesitate to admit these. Attorneys are, as they should be, expert at sawing off the limb on which a witness may have placed himself in a misguided effort to appear to know everything about something with which currently at least, he is not completely familiar.

An expert enjoys the unusual privilege in a court of law of offering

opinion. But this privilege carries with it the responsibility to be completely candid with the court.

Once a human factors psychologist has become involved in a case (after he has convinced himself that he is on the right side of justice as far as his area of expertise is concerned) it is tempting to become an advocate. He must resist this temptation. The attorney is the advocate; the expert is simply a person with special knowledge who is there to provide information that presumably would not be available otherwise (see figure on p. 1). Some people, in criticizing the "expert witness" practice, ask how it can be that both plaintiff and defense will have expert witnesses who will offer different opinions on the same issue. Such individuals do not understand the nature of science. Science is not a single set of immutable, never-changing principles. Controversy rages in science as it does in courts of law. It is hoped that, as a science grows and matures, there is less and less disagreement on certain fundamentals (the basic facts of science), but there will never be complete agreement on many issues. And some of these issues are frequently crucial in products liability cases.

Specification and Standards

The original purpose of specifications was to facilitate contractual agreements regarding the nature of the products or services to be delivered. Standards were found necessary to ensure reasonable identity of products. Without standards, mass production is impossible.

Standards can also facilitate competitive bidding and subcontracting, uniformity of testing methods, and uniform treatment of the data that result from tests. Guidance regarding safe design varies considerably among standards.

The United States of America differs from most other technological societies in that most of its standards are written and/or promulgated by private organizations. Foremost among such organizations is the American National Standards Institute (ANSI), which, along with the American Society for Testing and Materials (ASTM) and with some assistance from the Office of Engineering Standards Services of the National Bureau of Standards, produces approximately 35 percent of the voluntary standards in the U.S.A.

The American Society of Mechanical Engineers (ASME), the Institute of Electrical and Electronic Engineers (IEEE), the Society of Automotive Engineers (SAE), and other professional societies produce approximately 30 percent of the voluntary standards in this country. Trade associations, e.g., Electronic Industries Association (EIA), National Electrical Manufacturers Association (NEMA), and others, produce approximately 30 percent of the voluntary standards.

Product testing and certifying organizations such as the Underwriters' Laboratories (UL) and the American Gas Association Laboratories (AGAL) produce the remaining 5 percent of the voluntary standards. However, 5 percent constitutes approximately 60 percent of the consumer product safety standards. Altogether, there are more than 25,000 nationally recognized standards (Smith, 1981).

Standards have been developed largely by organizations that have many responsibilities of which safety is only one and, unfortunately, organizations whose interests are often represented by specialists in areas other than safety. (In 1984, the Board of Directors of the American Society of Safety Engineers made the important decision to become actively involved in the standards process.) Certainly none of the specialists who traditionally have worked on standards committees would knowingly support standards that would permit the design, manufacture, and distribution of unnecessarily hazardous products; nevertheless, without special training in safety engineering and knowledge of human capabilities and limitations, it is difficult to see how safety could be accorded the attention that it requires and deserves during the development of standards.

Peters has written forcefully and well on this topic in an article entitled "Why Only a Fool Relies on Safety Standards" (Peters, 1977). This outstanding authority identifies several deficiencies in U.S.A. standards. Peters' thoughts are presented in the table on page 4.

Colleges of engineering have a special responsibility to ensure that their graduates fully understand and appreciate their distinctive responsibilities with respect to making certain that the products they design, manufacture, and distribute are as safe as it is reasonably possible to make them (Christensen, 1977). Unfortunately, the colleges of engineering have not responded particularly well to this challenge. (Fortunately, there has been significant improvement since the referenced paper was written in 1977. However, when one considers the awesome and varied responsibilities that are placed on engineers in a technological society, one has to wonder if four years of intensive study is sufficient time to acquire the enormous amount of knowledge and skills that the modern engineer requires.)

In summary, the human factors psychologist should, indeed, obtain and carefully examine relevant standards. If he finds safety requirements that have not been met, he should certainly bring these to the attention of his attorney.

However, the human factors psychologist must recognize that the information contained in a standard with respect to safety often constitutes only *minimum* requirements. His analysis of hazards and safety requirements should not be constrained by the published contents of a standard. He may find it helpful to contact the individuals who served on the committee that developed the standard. If minutes of the committee's deliberations no longer exist, he may wish to try to have some of the members recount the rationale for certain decisions.

Continued on page 4

Deficiencies in U.S.A. Safety Standards (Adapted from Peters, 1977)

1. *Outdated Criteria.* Criteria change as time passes. Criteria are changed by such considerations as attitudes toward what constitutes acceptable risk (observe how some states vacillate regarding the wearing of helmets by those who ride motorcycles). The results of product liability suits alter criteria; new technological developments change products and their relationships to the individual, to the social environment, to other products; and so on. Also, as anyone who has served on a standards development committee can attest, years usually pass between the time the need for a standard is identified and the final document is generally available.

2. *Inconsistent Requirements.* Peters, quoting Hammer (1977), identifies three different standards for the discharge of capacitive circuits upon shutting off a power source (30, 50, or 60 volts in 2, 10, or 60 seconds)! One is well advised to look behind the printed document and attempt to determine the rationale on which the standard was based. While looking, he should examine carefully the nature of the organizations that the committee members represented. Were any safety organizations or human factors organizations represented?

3. *Risk Reduction, Not Hazard Elimination.* Peters cites an incredible instance in which a federal safety standard committee adopted a depth for swimming pools that would reduce by 60 percent the risk of injury from entering the pool via a slide! Why was not the reduction required to be as close as possible to 100 percent? Again, the expert must look behind the written word before he places complete faith in a standard.

4. *Incomplete Coverage.* Standards cannot conceivably cover all products (e.g., over 2,000,000 chemical compounds are now identified). New products enter the market so frequently that no standards organization currently in existence can keep up with them. Those who design and develop products for public distribution must often rely on their own good judgment, using the best information available to them.

5. *Minimal May be Sub-Minimal.* Peters points out that efforts to raise the level of standards in terms of safety requirements may cause some companies to cry "foul" and claim restraint of trade. The result is that some standards have to be watered down to the point that almost all the products they cover can claim adherence.

6. *Individuals.* Anyone who has served on various standards committees has encountered the situation where one person or a few persons from one or a few companies virtually dominate the proceedings. This is often done by volunteering to prepare first drafts—drafts that can hardly help but be favorable to the point of view of the preparer's company or agency. Drafts, if skillfully prepared, have an astonishing durability. Private individuals generally have neither the time nor the resources to serve effectively on standards committees.

7. *Stifles Research.* Peters points out that undue reliance on standards may cause a company to neglect safety analyses, testing, research — in a word, to neglect efforts to improve if current standards are being met. "Undue reliance on standards may lead to safety senility..." (Peters, 1977).

8. *Less Money for Research.* Legal obligations are undiminished by adherence to standards and, in fact, some of the resources devoted to their development and promulgation might have been more effectively spent on research, development of design guides for safety, etc.

The standard, then, is simply one more tool that the human factors psychologist employs in his attempt to determine whether or not the safety measures taken with respect to the design, manufacture, and distribution of a product were *reasonable.*

The designer will find, often to his dismay, that he must design not only for what he might consider reasonable use of this product but also for uses that he may not have anticipated—"forseeable misuse," as it is termed. ●

Julien M. Christensen, Ph.D., Sci. Dr., is a past-President of the Human Factors Society (now the Human Factors and Ergonomics Society), Chief of the Human Engineering Division of the Air Force Aerospace Medical Research Laboratory (now the Armstrong Laboratory), and currently Chief of Human Factors, Universal Energy Systems, Dayton, OH.

References

Christensen, J.M. (1977, December). Implications of product liability for engineering design and education. *Engineering Education, 68* (3).

Hammer, W. (1977). Which standards are wrong? *Hazard Prevention, 14* (2).

McElroy, F. (Ed.). (1974). *Accident prevention manual for industrial*

THE COTR SPEAKS

Reuben L. Hann

Would you know how to prepare yourself, if you were asked to act as a human factors expert witness in a product liability case? Increased awareness of the importance of human factors in design has led to suits being brought against manufacturers and others, charging that a product is unsuitable or unsafe for use by a human operator. Often, ergonomics practitioners are being called to give expert testimony in such cases. In this issue, Dr. Julien Christensen, an expert in the area of human factors and the law, begins a two-part feature article on the role of human factors in the court room. Here, he focuses on what is expected of the expert witness, and discusses the problem of "bad" specifications and standards used in developing new products.

The 1993 edition of the very successful Human Engineering Division/Armstrong Laboratory Colloquium Series: The Human-Computer Interface began with a presentation by Dr. David Woods, The Ohio State University. Dr. Woods spoke about "Clumsy Automation, Practitioner Tailoring, and System Disaster." Dr. Bill Moroney, University of Dayton, has written a review of this presentation, and I had the opportunity to speak with Dr. Woods following his presentation. Portions of our conversation have been transcribed and included here.

We try to feature a different government program in each issue of *Gateway.* This time Joe Galushka and Dwight Lindsey of the U.S. Army Safety Center at Fort Rucker, Alabama describe their important mission in supporting *Army Safety 2000.*

This issue's technology transfer article, by Dr. David Matson of the Naval Biodynamics Laboratory, relates a new treatment for chronic motion sickness which combines the use of cognitive and behavioral training.

Rounding out this edition, Dr. Glenn Wilson, Armstrong Laboratory, reviews the proceedings from the workshop "Cardiorespiratory Measures and Their Role in Studies of Performance." These are featured in a special issue of *Biological Psychology,* which is available through CSERIAC.

As always, your comments , suggestions, and letters to the editor are welcome. Please submit them to Jeff Landis, Editor, CSERIAC Program Office, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022. Also, if you know of anyone not receiving *Gateway,* who should be on our mailing list, please let us know. ●

Reuben "Lew" Hann, Ph.D., is the Contracting Officer's Technical Representative (COTR) who serves as the Government Manager for the CSERIAC Program.

Forensic continued

operations (7th ed.). Chicago: National Safety Council.

Peters, G.A. (1977). Why only a fool relies on safety standards. *Hazard Prevention, 14* (2).

Philo, H. M., Robb, D.A., & Goodman, R.M. (1975). Technical sources for conducting a personal injury action. *Lawyer's Desk Reference* (5th ed.). Rochester, NY: The Lawyers Co-Operative Publishing Company.

Smith, C. D. (1981). *Products liability: Are you vulnerable?* Englewood Cliffs, NJ: Prentice-Hall.

Footnotes

1 I am grateful to Hemisphere Publishing Corporation for permission to reproduce material that I prepared for Hemisphere's *Psychology in Product Liability and Personal Injury Litigation* (M.I. Kurke & R.G. Meyer, Eds., 1986).

2 These introductory remarks are based partially on an invited paper that I gave at an ASME-ASNT-NBS Symposium on "Non-Destructive Evaluation (NDE): Reliability and Human Factors," October 1981.

3 I am happy to report that in the past couple years the number of deaths per year in U.S. industry has decreased from approximately 14,000 to 10,500 and the number of deaths per year in the American home has decreased from approximately 30,000 to 23,500. It is my fervent hope that this trend will continue. It surprises many to learn that approximately twice as many people are killed accidentally in the American home as are killed accidentally in American industry.

4 For our purposes, *hazard* ($\overline{H}$) is defined as a condition or set of circumstances that has the potential of causing, or contributing to, injury or death. *Risk* ($\overline{R}$) has to do with the probability of an undesirable event occurring. *Danger* ($\overline{D}$) then, is defined as a function of hazard and risk. While we cannot define this complex function with exactness yet, we do know that $\overline{H}$ or $\overline{R}$ will be expressed multiplicatively and not additively since reduction of either $\overline{H}$ or $\overline{R}$ to zero, reduces $\overline{D}$ to zero.

Book Review

Set Phasers on Stun and Other True Tales of Design Technology and Human Error

Steven Casey

Reviewed by Dieter W. Jahns, SynerTech Associates

221 pages, $24.95 (hardcover, 1993)
ISBN 0-9636178-7-7
Agean Publishing Company
P.O. Box 6790
Santa Barbara CA 93160
805-694-6669

The popular conceptualization of "accidents" can be traced historically as moving from acts-of-God, through acts-of-nature to acts-of-man. As scientists and engineers become increasingly adept at harnessing the forces and material resources of nature, the overall human condition improves, but at a cost: *unsafe acts* by humans replace *unsafe conditions* in the causation attributions regarding mishaps and personal injury events. A person carefully using new technologies, as intended by their designers, will benefit and not be hurt. There is however, a latent hazard in this type of thinking. People as users of technology are adaptive, flexible, and creative; they assume that engineered nature is safer than raw nature. They trust technology and themselves in the use of it.

In *Set Phasers on Stun...* Steven Casey amply and effectively demonstrates the divergent ways in which technology can overwhelm the unsuspecting end-users of simple and complex devices. None of the people portrayed in the eighteen stories of the book suspected that they were doing anything wrong in their performance of routine tasks. Some survived to tell about it, others did not. The book is a litany of human factors engineering (or ergonomics) examples in which either the scientific knowledge and principles of ergonomics were not used or were used incorrectly. Written in an immensely readable, fascinating way, the stories provide case studies of human/technology mismatches devoid of the professional jargon of engineers, ergonomists, and lawyers. Yet each story is factual and augmented by a reading list for further research. Thus the book becomes useful for a variety of purposes beyond tragic entertainment. For students and practitioners of ergonomics, the stories can serve as the basis for discovering design-induced-human-errors and for designing and evaluating potential solutions. For engineers the book can serve as examples of how people in fact *do* function rather than how we all wished they *would* function. That is, human performance is probabilistic, not deterministic. For both communities, the book can serve as a reminder that engineers and ergonomists must learn to coordinate, cooperate, and integrate their professional efforts if raw nature and human nature are to be harnessed effectively for an ecologically sound and socially just world.

Technology managers, policy makers and attorneys can quickly deduce from the book how reliance on "common sense"

Calendar

July 4-8, 1993
Paris, France
Biomechanics: 14th International Society of Biomechanics Congress. Contact Convergences — ISB '93, 120, avenue Gambetta, 75020 Paris, France; fax (33) 40-31-01-65.

July 11-15, 1993
Washington, DC, USA
AAAI-93, 11th National Conference on Artificial Intelligence, and IAAI-93, 5th Innovative Applications of Artificial Intelligence Conference. Contact AAAI, 445 Burgess Dr., Menlo Park, CA 94025-3496; (415) 328-3123, fax (415) 321-4457.

July 21-23, 1993
Ann Arbor, MI, USA
Warnings, Labels & Product Packaging: Design & Compliance. University of Michigan Engineering Conferences. Contact Engineering Conferences, 100 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109-2092; (313) 764-8490, fax (313) 936-0253.

July 26-29, 1993
Ann Arbor, MI, USA
Intelligent Vehicle-Highway Systems. University of Michigan Engineering Conferences. Contact Engineering Conferences, 100 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109-2092; (313) 764-8490, fax (313) 936-0253.

August 2-13, 1993
Ann Arbor, MI, USA
Human Factors Engineering. University of Michigan Engineering Conferences. Contact Engineering Conferences, 100 Chrysler Center, North Campus, The University of Michigan, Ann Arbor, MI 48109-2092; (313) 764-8490, fax (313) 936-0253.

August 8-13, 1993
Orlando. FL, USA
HCI International '93: 5th International Conference on Human-Computer Interaction. Contact Gavriel Salvendy, 1287 Grissom Hall, Purdue University, West Lafayette, IN 47907-1287; (317) 494-5426, fax (317) 494-0874.

August 16-26, 1993
Eindhoven, Netherlands
Basics of Man-Machine Communication for the Design of Educational Systems, sponsored by NATO Advanced Study Institute. Contact Institute for Perception Research, Ilse van Kuijck, P.O. Box 513, 5600 MB Eindhoven, Netherlands; (31) 40-77-3876; fax (31) 40-77-3874.

August 20-24, 1993
Toronto, Ontario, Canada
101st Convention of the American Psychological Association. Contact APA Convention Office, 750 First St., NE, Washington, DC 20002-4242; (202) 336-5500, fax (202) 336-5708.

August 22-24, 1993
Kansas City, MO, USA
Association of Driver Educators for the Disabled Annual Conference. Contact Michael Shipp, Louisiana Technical University, 711 S. Vienna, Ruston, LA 71270; (318) 257-4562, fax (318) 255-4175.

Notices for the calendar should be sent at least four months in advance to:
CSERIAC Gateway Calendar, AL/CFH/CSERIAC Bldg 248, 2255 H Street, Wright-Patterson AFB OH 45433-7022

and the experiences of ordinary people can mask the true complexitites of human performance in mishap scenarios.

Some of the settings will be familiar to some readers (e.g. Bhopal, the Airbus A320, *Herald of Free Enterprise* auto ferry), but many are new or told from a new perspective. The author has a unique talent for putting the reader into a situation: the automated bridge of the supertanker *Torry Canyon* ; by the bedside of a child being hooked up to high-tech medical devices for status monitoring; to an operations center of ConEdison before the lights go out in all of Manhattan. All tales are told from the perspective of the user of technology which, in turn, is seen to be incompatible with the way people perceive, think, and act. The striving for an "accident-free" world may be utopian, but Steven Casey has written a book that demonstrates to laypeople and technocrats alike how far away we are from adequately controlling hazards and managing risks. How safe is safe enough? Read the book and you will be better able to judge and plan ahead.

Letters to the Editor

Dear Dr. Meister:

I enjoyed and fully empathized with your article on non-technical influences on human factors. For nine years in the Air Force, I attempted to develop a system which would produce a predictive data base of human factors related to aircraft accidents. Although not failing completely, I felt that the effort fell far short of its potential, due mostly to political and other non-scientific reasons.

I still believe that it is entirely possible to develop a predictive database of human factors issues. I respect, as do you, Dr. Boff's *Compendium*, but agree that it does not predict or even suggest alternatives to real-life problems Also, it omits many of the determinants of human functions a behavioral scientist needs to even describe behavior, let alone predict it.

What you indicate is needed has been attempted, but the time was not right. I hope that others of your insight will help bring human factors psychology into the 21st century.

Stan Santilli
Lt Col USAF (Ret)
Oceanside, CA

Correction

In the last issue (Vol. IV, No. 1), on page 11 the caption for the second figure should have read "Dr. Griffin advised his audience that when designing interfaces, they should consider that wide fields-of-view can lead to nausea." It was an editorial error that suggested that wide fields-of-view be avoided. JAL

September 9-11, 1993
Glasgow, Scotland
5th International Conference on Vision in Vehicles, sponsored by the Applied Vision Association and others. Contact VIV5, Academic Radiology, University Hospital, Queens Medical Centre, Nottingham, NG7 2UH, England; (44) 602-709442, fax (44) 602-709140.

September 20-22, 1993
Vienna, Austria
1st Vienna Conference on Human-Computer Interaction. Contact Monika Fahrnberger, Department of Computer Science, Technical University of Vienna, Resselgasse 3/188, A-1040 Vienna, Austria.

September 26-October 1, 1993
Nice, France
24th International Congress on Occupational Health, sponsored by the International Commission on Occupational Health. Contact Comite d'Organisation du 24e Congres International de la Sante au Travail, C.O. 24 France, "Les Miroirs," Cedex 27, 92096 Paris la Defense, France; (33) 1-47-62-33-70, fax (33) 1-47-62-31-53.

October 4-7, 1993
Palermo, Italy
Italian Ergonomics Society Fifth National Conference, in conjunction with the IEA International Symposium. Contact Annie Alemani, Societa Italiana di Ergonomia, Via San Barnaba, 8, 20122 Milan, Italy; (39) 2-5799-2163, fax (39) 2-5518-7172.

October 4-8, 1993
Denver, CO, USA
126th Meeting of the Acoustical Society of America. Contact Acoustical Society of America, 500 Sunnyside Blvd., Woodbury, NY 11797-2999; (516) 576-2360.

October 11-15, 1993
Seattle, WA, USA
Human Factors and Ergonomics Society 37th Annual Meeting. Contact HFES, P.O. Box 1369, Santa Monica, CA 90406-1369; (310) 394-1811, fax (310) 394-2410.

October 19-22, 1993
Montgomery, AL, USA
First Annual Quality Air Force Symposium '93 sponsored by the U.S. Air Force Quality Center. Contact Major Brian Zak, AFQC/RS, Bldg. 1400A, 825 Chennault Circle, Maxwell AFB, AL 36112-6425; (205) 953-3306, fax (205) 953-3132, or Wes Grooms, Conference Coordinator, AL/CFH/CSERIAC, Bldg. 248, 2255 H Street, Wright-Patterson AFB, OH 45433-7022; (513) 255-4842, DSN 785-4842, fax (513)255-4823, DSN fax 785-4823.

October 21-24, 1993
Memphis, TN, USA
Biomedical Engineering Society Annual Fall Meeting. Contact Eugene C. Eckstein, Dept. of Biomedical Engineering, University of Tennessee, Memphis, 899 Madison Ave., #801, Memphis, TN 38163; (901) 528-7099, fax (901) 528-7383. *Abstract deadline: June 1, 1993.*

October 28-31, 1993
San Diego, CA, USA
IEEE Engineering in Medicine and Biology Society 15th Annual Meeting. Contact Andrew Y.J. Szeto, Dept. of Electrical and Computer Engineering, San Diego State University, San Diego, CA 92812; (619) 594-5695, fax (619) 594-6005.

Announcements

Liveware Survey & Database Progress

The DoD Liveware survey and database have now reached 500 technologies. At this point, project manager, Dr. Mona Crissey and subject matter expert, Frank Gentner, have begun analysis of the technologies in the database. Meanwhile surveys continue to arrive, and plans are being made to transition the Liveware survey database. These are just a few of the happenings during the past few months. We'll address each below.

Findings

Liveware survey sponsor, Mr. Mike Pearce of OASD (FM&P) /R&R(TFM) HSI office, Dr. Crissey, and Frank Gentner would like to thank those 579 people who have participated in the Liveware survey to date. Participants include 258 technology owners, 221 owner/user/developers, 74 users, and 26 distributors.

The table presents the number of technologies in the Liveware database by Service or organizational affiliation for each of the Liveware domains.

LIVEWARE SURVEY PARTICIPATION
BY SERVICE/INDUSTRY (As of April 1993)

LIVEWARE DOMAIN	UNITED STATES AIR FORCE	ARMY	NAVY MARINES	OTHER GOV'T	INDUSTRY	UNIVERSITIES	TOTAL BY DOMAIN
MANPOWER	54	44	15	25	103	7	248
PERSONNEL	43	44	12	25	99	8	231
TRAINING	68	52	37	33	126	8	234
SAFETY	27	18	8	19	87	6	165
HEALTH HAZARDS	21	16	7	18	71	4	137
HUMAN FACTORS ENGINEERING	48	42	11	30	112	11	254
INTEGRATION	38	23	15	23	79	8	186
Number of Technologies in Database	116	85	52	60	174	13	500

Note: Each technology can impact more than one domain

Of the 500 technologies in the Liveware database on April 15, 1993, 62 percent were "tools", 25 percent databases, and 13 percent techniques (see Figure 1). Most were non-proprietary (see Figure 2) and available for use. These technologies supported all system types, system levels, mission areas, and acquisition phases. Most (84%) listed technologies were complete and ready for use. Of the 405 computer-based technologies, 175 (43%) were available for use on IBM PC-compatible computers, 104 for engineering workstations, but only 29 for Macintosh systems . We made special efforts to identify Mac-based tools, but only increased these kinds of survey returns from 9 to 29. Therefore, if you are aware of other Mac-based HSI technologies, please let us know. One of the most significant survey findings and areas for HSI technology improvement was that of the 500 technologies listed, 400 (80%) reported no validation studies (see Figure 3).

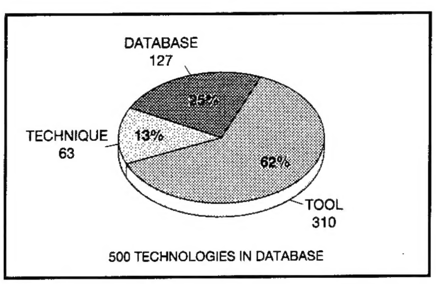


Figure 1. Technology type.

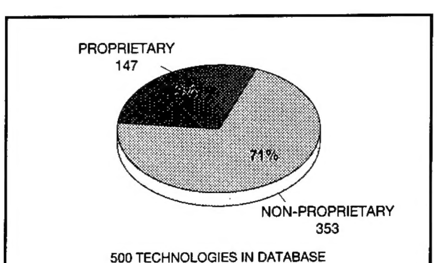


Figure 2. Technology ownership (proprietary vs. non-proprietary).

Over 254 technologies support Human Factors Engineering analyses. Examining the Human Factors Engineering subdomains (see Figure 4), we found the highest participation was in the area of performance and workload (177 technologies). Human-machine interface had 139 technologies; mission, function, and task analysis had 136; information transfer, 88; work-space/anthropometry, 86; and life support/environment had 78 technologies providing support (In case you noticed that the sum of these sub-domains is larger than the total number in human factors engineering, remember that any tool can support multiple domains and/or sub-domains).

A detailed report of the survey findings is being prepared for the NATO Research Group (RSG. 21), that commissioned the study. Also, a catalog of these tools is being developed for publication mid-summer.

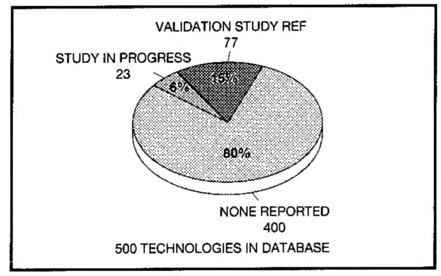


Figure 3. Number of validation studies/ reference.

Future of the Liveware Survey & Database

The Liveware database was originally scheduled to be hosted by the Defense Training and Performance Data Center (TPDC). Since TPDC was disestablished as part of downsizing, the Defense Technical Information Center's Manpower And Training Research Information System (MATRIS) has offered to place the Liveware database on line for its users. They have begun the process of converting the PC Focus database to a BASIS Plus document database management system on their VAX/OpenVMS system. MATRIS will store the primary Liveware database, with updates to be added as owners/users/developers furnish new information. The shift in responsibility is scheduled for July 1, 1993. An on-line date has not yet been set.

CSERIAC is also exploring making this same database available on an exportable hypertext information database (infobase) for a cost-recovery fee. Periodic updates would be made available from the primary MATRIS database. An infobase prototype using Folio Views has demonstrated extremely fast and flexible search capabilities. In fact, the Liveware database has already helped to locate needed human factors software packages for several technical inquiries to CSERIAC.

We'll let you know about the availability of both the on-line and infobase versions in future *Gateway* issues. Meanwhile we are continuing to

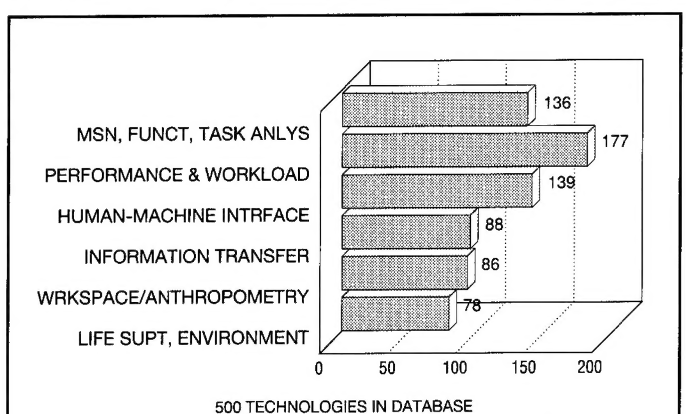


Figure 4. Human factors engineering subdomains supported.

add more technologies. We therefore encourage you to provide new or updated information about your human system integration technologies.

To obtain a survey or further information, contact Dr. Mona Crissey at Department of the Army, Chief, ARL-HRED-STRICOM Field Element, ATTN: (Dr. Mona Crissey), 12350 Research Parkway, Orlando, FL 32826-3276; (407) 380-4277, DSN: 960-4277, FAX: (407) 381-8790, E-mail: CrisseyM@Orlando-EMH3.Army.MIL. She is the Liveware Project Manager.

Or contact Frank C. Gentner or Dave Kancler at AL/CFH/CSERIAC, 2255 H Street, Bldg. 248, Wright-Patterson AFB, OH 45433-6573, (513) 255-4842, DSN: 785-4842, FAX: (513) 255-4823, E-mail: FGentner@FALCON.AAMRL.AF.MIL. They are the CSERIAC technical analysts assisting Dr. Crissey with the Liveware project.

Certification for Ergonomists and Human Factors Professionals

The Board of Certification in Professional Ergonomics is now accepting applications for professional certification of ergonomics and human factors practitioners. Applicants should have a mastery of ergonomics knowledge and methods, as well as expertise in the analysis, design, and evaluation of products, systems, and environments for human use. Qualified applicants may choose to be certified as either Certified Professional Ergonomists (CPE) or as Certified Human Factors Professionals (CHFP). Applications are available from Board of Certification in Professional Ergonomics, Office of the Executive Director, P. O. Box 2811, Bellingham, WA 98227-2811, USA, phone: (206) 671-7601 fax: (206) 671-7681.

Minimum qualifications are an MA/MS or equivalent in ergonomics or a closely related field and 7 years of demonstrable experience in the practice of ergonomics. Applications are open to ergonomists internationally.

Certification will be based on an evaluation of work samples and supporting documentation through December 31, 1993. The application processing fee is US$200 (nonrefundable) with an annual renewal fee of $75. After December 31, 1993, applicants will be required to pass a written examination.

The Board of Certification in Professional Ergonomics was formed as a nonprofit corporation in 1990. Although the Board was established with support from the Human Factors Society, it is independent of any professional, scientific, or trade association.

Current members of the Board are Alphonse Chapanis, Ph.D; David Meister, Ph.D.; Melvin H. Rudov, Ph.D.; Hal W. Hendrick, Ph.D.; George A. Peters, J. D.; H. Harvey Cohen, Ph.D.; David J. Cochran, Ph.D.; Jerry R. Duncan, Ph.D.; Steven M. Casey, Ph.D. The Executive Director is Dieter W. Jahns, M.S.

Industrial Ergonomics Bibliography

The Human Factors and Ergonomics Society has revised its guide to the literature on industrial ergonomics, "Industrial Ergonomics Bibliography." The new brochure is free of charge and lists publications that contain data useful for the design of jobs in industry.

The bibliography is divided into six sections, in addition to lists of periodicals and proceedings: *General* lists texts and handbooks; *Worker Characteristics* covers size, strength, age, and gender; *Job Design* addresses productivity, human error, fatigue, and accidents; *Equipment Design* concerns displays, controls, and tools; *Workplace Design* includes information on chairs, benches, floors, and stairs; and *Environmental Design* covers heat, noise, vibration, and illumination.

The bibliography is designed for human factors practitioners, industrial engineers, safety professionals, occupational physicians and nurses, industrial hygienists, personnel specialists, managers, labor union officials, and workers.

To obtain a free copy of the "Industrial Ergonomics Bibliography," contact the Human Factors and Ergonomics Society, P.O. Box 1369, Santa Monica, CA 90406-1369; (310) 394-1811, fax (310) 394-2410.

Human Engineering Division/Armstrong Laboratory Colloquium Series

Clumsy Automation, Practitioner Tailoring, and System Disaster

David D.Woods
Reviewed by William F. Moroney

Editor's Note: Following is a review of a presentation by Dr. David Woods as the first speaker in the 1993 Human Engineering Division/Armstrong Laboratory Colloquiium Series: The Human-Computer Interface. This review was prepared by Dr. William F. Moroney, a Professor of Psychology with the University of Dayton, Dayton, OH. JAL

I have always associated situational awareness with the dynamic fast-changing aviation environment, primarily with air-combat maneuvering, and to a lesser degree, with commercial aircraft. However, since Dave Woods' presentation, I now view situational awareness in a new light; analogous to workload, it is all pervasive and critical to understand if we are to progress beyond top-level Human-Computer Interface (HCI) design and contribute to the area of Human-Computer Cooperation (HCC).

The basic theme of Woods' presentation was that the clumsy use of automation in an attempt to eliminate human error often becomes the source of new types of error or failure. He describes several attempts at clumsy automation which creates new burdens or potential errors for beleaguered practitioners. Initially, he described the proliferation of "windows" which provide the operator with a keyhole look at the world, while denying the operator any "peripheral vision." One slide showed the control room of a French nuclear power plant with eight CRTs, on which 17,000 different display formats could be presented. Clearly this operator needed a navigation system to maintain situational awareness.

A photograph of comparatively new, expensive, high-technology, automated medical equipment stacked in a hallway awaiting disposal struck a resonant chord, as it illustrated the cycle of "vaunted introduction and veiled discards." Woods described an anesthesiologist as a "process controller" who manipulates the dosages, mixtures, and sequence of drug delivery during heart surgery. He then illustrated how new, clumsy technology denied anesthesiologists access to critical information at critical times. Indeed, paradoxically, on four occasions, the chain leading to a critical incident was broken only because an anesthesiologist intervened. In the subsequent incident analysis, it became apparent that the automated device provided little or no feedback about the actual events occurring.

It's easy to create the potential for mode errors with computer-based automated systems. With some automated systems, other operators or the computer may change modes due to situational circumstances or system factors. These indirect mode changes often lead to some automation surprises when the operator loses track of what mode the automated system is in. Rather than having less workload, the user is now required to track the state of the automated device, manage the interface, dedicate attentional resources to the task, execute new communication tasks, learn new tasks to meet the knowledge demands, and know about each mode and option.

Woods illustrated that the power of graphic displays, used decoratively, often don't provide the necessary information. It is easy to proliferate new displays and windows without helping the user to know where to look next or to highlight that which is informative. When confronted with such confusing information, practitioners use only a small set of the large amounts of data available. If we are to achieve real cooperation between humans and computers, then the power of the computer medium must be used to highlight contrasts, events, and changes in the data.

The reader may ask "Why aren't these problems caught during earlier testing?" There is an interesting process at work here. Because practitioners are responsible, they often work to smoothly accommodate the new technology. Indeed, their tailoring of the technology and/or their task may hide the clumsiness from the designers. In short, practitioners change their strategies as a function of the tools provided.

According to Woods, the cost of clumsy automation becomes most apparent during periods of critical events and under high tempo conditions. Bad design is a type of latent failure that can contribute to disasters if other factors are present.

How should one cope with technology-induced complexities? Some of the observed strategies for coping with complexity include a) scheduling device interaction during low workload periods; b) encouraging spatial

reasoning by maintaining the same information in the same location across modes; c) developing stereotypical routes and methods to avoid getting lost; and d) providing consistent escape strategies which allow the practitioner to escape to less complex levels.

Automation by itself without accounting for people in systems easily leads to new kinds of complexities that Woods described in his lecture. System developers who turn to automation to solve problems need to press beyond simple human-computer interaction and strive for real human-computer cooperation. ●

David D. Woods, Ph.D., is an Associate Professor of Industrial and Systems Engineering, and Co-Director of the Cognitive Systems Engineering Laboratory, The Ohio State University, Columbus, OH.

Readers interested in pursuing this topic further can consult:

Cook, R.I., Potter, S.S., Woods, D.D., & McDonald, J.M. (1991). Evaluating the human engineering of microprocessor-controlled operating room devices. *Journal of Clinical Monitoring, 7*, 217-226.

Sarter, N.B., & Woods, D.D. (1992). Mode error in supervisory control of automated systems. *Proceedings of the 36th Annual Meeting of the Human Factors Society* (pp. 26-29). Santa Monica, CA: Human Factors Society.

Woods, D.D. (1993). The Price of Flexibility. *Proceedings of International Workshop on Intelligent User Interfaces.* New York: Association of Computing Machinery.

Yue, L., Woods, D.D., & Cook, R.I. (1992). *Reducing the potential for error through device design: Infusion controllers in cardiac surgery* (Report CSEL 92-TR-02). Columbus, OH: The Ohio State University, Cognitive Systems Engineering Laboratory.

Scenes from the Human Engineering Division/ Armstrong Laboratory Colloquium Series:

Dr. Woods was the opening speaker for the 1993 Human Engineering Division/Armstrong Laboratory Colloquium Series: The Human-Computer Interface, speaking on "Clumsy Automation, Practitioner Tailoring, and System Disaster."

Dr. Woods detailed the problems often encountered by anesthesiologists when trying to use equipment designed with the intention of facilitating the process of administering anesthetic, but that hinders the process because of the poor use of design principles.

Human Engineering Division/Armstrong Laboratory Colloquium Series

A Conversation with David Woods

Reuben L. Hann

Editor's Note: The following is an edited transcript of a conversation with Dr. David Woods, who was the first speaker in the 1993 Human Engineering Division/ Armstrong Laboratory Colloquium Series: The Human-Computer Interface. The interviewer was Dr. Lew Hann, CSERIAC COTR. JAL

CSERIAC: You were trained as a psychologist, but I see your office is in one of the Engineering Department buildings here at Ohio State. Why is that?

Dr. Woods: I am a cognitive psychologist "in exile" in Engineering, because I play too much with the real world. I like being in the Engineering Department at the undergraduate level. For what we do, we have the most influence by teaching undergraduate engineers. This way we can expose them to the human side of technical systems, and we remind them that technical systems *always* have a human component.

"In some sense, our research is trying to say that there is no technological imperative—that technology represents power, and that design is about *choosing among the possibilities* for using that power."

CSERIAC: You are a recognized authority in the area of human error. How did you get interested in this subject?

Dr. Woods: In a sense, it all started with an energetic re-examination of the question "Why do errors happen?" It was driven by real disasters that were happening at that time. I finished my Ph.D. in 1979, which you will recall is about the time of the Three Mile Island event. I went to work at the Westinghouse Research Center, where we had considerable freedom to pursue answers to the questions of why it happened, how the operators made the wrong decisions, and–in my case–how we could use computer decision-aiding, so that such situations can be avoided in the future. So I was able to immediately start looking at the question of how operators make decisions in dynamic, very complex settings. We quickly realized that you can't study persons in isolation from the tools they use. I think laboratory experimental psychology has strayed from the fundamental fact that what defines people as an intelligent species has always been the creation and use of tools. That is the hallmark of intelligence. Yet in the laboratory we study people without tools. But when we go into the real-world, we realize that what makes people intelligent is how they create and skillfully use a variety of tools–not just for physical, but also for mental work. Memory aids are one of the most common examples.

When you study people working in the control room, the other thing that doesn't fit with laboratory psychology is that nobody does things alone. We realized that you can't look at this as an individual decision process, then as a group, and then as an organizational process. It is fundamental to remember that you are dealing with multiple interacting agents.

A third factor was the development of artificial intelligence (AI) systems. So, often you had a situation where one of the team members was a machine.

The outcome of this was the need to study teams of people interacting with machines and cognitive tools, and the realization that applied settings were really a way to do basic research while being able to accomplish things relevant to real problems.

CSERIAC: During your presentation you used examples of how *not* to design a human-computer interface. You got that from Donald Norman, I believe.

Dr. Woods: That's right. It's from his book, *The Psychology of Everyday Things.* It's a clever way to wake people up by showing them how to do things wrong. It includes such things as: Hide things, make them invisible, exploit the tyranny of the blank screen; use arbitrary labels or sequences–computers make this easy; be inconsistent–do things one way in one mode and differently in another. In our work we have been trying to focus on human error as a symptom instead of a cause. We use human error as a starting point, to try to trace back in the design process and find out how technology shapes what designers do which in turn might create systems with these typical kinds of problems. That raises the consciousness of designers and others so that we can see where the problem really lies, rather

than blame the practitioner. They can see how various kinds of error traps were created.

CSERIAC: It sounds like these are the "latent errors" mentioned by James Reason, who spoke at one of our earlier colloquia.

Dr. Woods: Exactly. The idea is that behind human error there are latent problems, and that sometimes they lie within the operational organization itself. But you can also find them within the design organization. In some sense, our research is trying to say that there is no technological imperative–that technology represents power, and that design is about *choosing among the possibilities* for using that power. The more advanced the technology, the more the possibilities, so that with this broader freedom we have a greater chance not only to succeed, but also to *fail.*

CSERIAC: What about the notion of "tailoring" of the interface by the operator? A famous example is the nuclear power plant control room where operators had installed beer tap handles on some of the controls, to aid in distinguishing them. Are you able–or *should* you be able–to do this with computerized interfaces?

Dr. Woods: There are ways to do this, but I think it is missing the point. The question is, what is the user expert at? The user is our ultimate data source in measuring success, but to say that, *ergo,* they should act as designer, misses an important point. That is, what they are expert at is their field of practice: the conditions they must work under, what goes wrong, what makes the task difficult, and so forth. But just because they are experts in their field of practice does *not* mean they are expert designers. User-designers are good at incrementally changing the system; that is, they are good at finding better ways for coping with a problem. However, they *don't* have the ability to change the design so that the problem does not exist in the first place. Humans are very good at coping with complexity, but that helps to create a paradox: Operators are responsible for outcomes in their field of practice, and are therefore constantly tailoring their strategies and tools to achieve their goals. Their tailoring to cope with complexity created by clumsy automation hides the clumsiness from the designers. So, when a problem "leaks through" their defenses, they blame themselves, or others blame them. The fact is, there are latent factors, like the clumsy use of technology, constantly "pushing" on the best defenses of the operator.

CSERIAC: I would like to close with a question I have put to others in this speaker series: If you had substantial financial resources, and were able to choose a research area which you felt deserved special attention, what would you choose?

Dr. Woods: I think the problem of our day is data overload. Regardless of the system, data overload is all around us. In some sense we have all experienced it, yet we have no good way to attack it. We attack it either by giving the operator everything–let people sort through it, or we use a kind of filtering, that is, since people can't handle all of it, we'll just give them part of it. The problem is, we never know if we are giving them the right part, because it depends on the context. AI researchers have tried to build automatic decision makers. What they haven't tried to tackle is how to help people to interpret what *might* be interesting, that is, how do we provide the salient information when the user needs it. That is the problem I would attack, because progress there has a high potential payoff in any given area, and would have broad relevance to almost any field of activity which goes on in this country. ●

The U.S. Army Safety Center and Human Factors

U.S. ARMY SAFETY CENTER®

Joe Galushka
Dwight Lindsey

Accidents during wartime have exacted a greater toll on Army resources than enemy action in every war except Korea. Fiscal year 1992 was the Army's safest year on record, yet accidents cost 239 lives, over 4,800 military personnel injuries, and more than $210 million.

About 80 percent of these accidents were caused by "human error." The Aviation Branch proponent described the significance of this problem well by saying that every mission we execute is a fight against two enemies, human error and the declared enemy.

This evidence, in conjunction with the increased demands of limited budgets and a leaner Army, challenges us to improve "human-system integration" (HSI). Improved HSI will allow us to reduce human factors hazards that cause accidents, take lives, destroy warfighting systems, and diminish our warfighting capability.

Agency and Mission

The U.S. Army Safety Center (USASC), located at Fort Rucker, AL, is a Field Operating Agency of the Army Chief of Staff. The Army safety mission is to protect the force and enhance warfighting capability through a systematic and progressive process of hazard identification and risk management.

This includes providing commanders mission-oriented policies, procedures, standards, and proactive accident prevention programs that integrate safety and risk management into doctrine, training, material acquisition, sustainment, and combat.

The Army Safety Center's plan to accomplish this mission is Army Safety 2000. This is a customer-focused effort to motivate processes which result in high-quality, value-added products that support commanders, major Army Commands, and installations. The concept is process-focused with customer participation.

Table 1
Scope of Activities

- Aviation
- Ground
- Installation
- Ammunition/Explosives
- Tactical
- Environmental
- OSHA
- Chemical/Biological
- Systems
- Family
- Nuclear

Areas of Human Factors Safety Influence

Human factors play a key role in carrying out all aspects of the Army Safety Program and Army Safety 2000 across the multitude of human-machine-environment interfaces Army-wide. The scope of these activities is given in Table 1.

Following are descriptions of some of the human factors processes/activities conducted at USASC.

Research, Development, Testing and Evaluation of Major Acquisition Systems

It is important to ensure that safety-related human factors hazards have been identified and resolved in the weapons systems the Army is acquiring or modifying, particularly for crew stations. The Army Safety Center participates in all major materiel acquisi-

tion programs and other selected programs from aviation to intelligence and electronic warfare. Functions include safety oversight/evaluation, independent safety assessments, providing human factors lessons learned from accident data, and providing direct technical support to program managers in System Safety, MANPRINT, Crew Station, and other work groups.

Investigation of Major Army Aviation and Ground Accidents

USASC personnel investigate all Class A aviation accidents and selected Class A ground accidents. A major part of each investigation is conducted by a human factors group. Technical expertise of human factors personnel from other agencies (military and industry) is integrated into the process. The accident findings and other data are documented in official reports and added to an automated database (described below). These findings address the systemic causes of errors/failures in areas such as individual indiscipline, training, design, procedures, and supervision (see Table 2).

Human Factors Data for Ground and Aviation Systems

The Army Safety Management Information System (ASMIS) is a computer database maintained at the USASC. It contains a wealth of information for human factors professionals on Army-wide problems being experienced by the "user." This automated information can be accessed via terminal or modem from areas throughout the world to support the programs of researchers, trainers, materiel developers, testers, combat developers, etc. An effort is currently underway to develop a single-source database of HSI safety issues from all accident and non-accident sources to support these customers.

Accident Research, Studies, and Prevention Programs

The Research, Analysis, and Studies (RAS) branch of the Army Safety Center conducts both in-house and contract studies in areas as diverse as aviation crew coordination and track-vehicle fire protection. These studies identify systemic sources of problem areas within the human-machine-environment interface that are causing accidents. Results from these studies are integrated with information from industry, academia, and other government agencies and developed into customer-focused products/programs. USASC prevention programs initiatives directly impact

Continued on page 17

Table 2
Sources of Human Error in Army Accidents

Individual (48%)	Soldier knows & is trained to standard but elects not to follow standard (self-discipline) ■ Attitude ■ Haste ■ Alcohol, drugs ■ Overconfidence ■ Fatigue (self-induced)
Leader (18%)	Leader does not enforce known standard ■ Direct supervision ■ Unit command supervision ■ Higher-command supervision
Training (18%)	Soldier not trained to known standard (insufficient, incorrect, or no training on task) ■ School ■ Unit ■ Experience, OJT
Standards (8%)	Standards/procedures not clear or practical, or do not exist ■ Task–Condition–Standard ■ Operating procedures (AR,TM, FM, SOP, etc)
Support (8%)	Equipment/personnel/material improperly designed/not provided; inadequate maintenance/facilities/services

Chronic Motion Sickness Treated with Cognitive-Behavioral Training

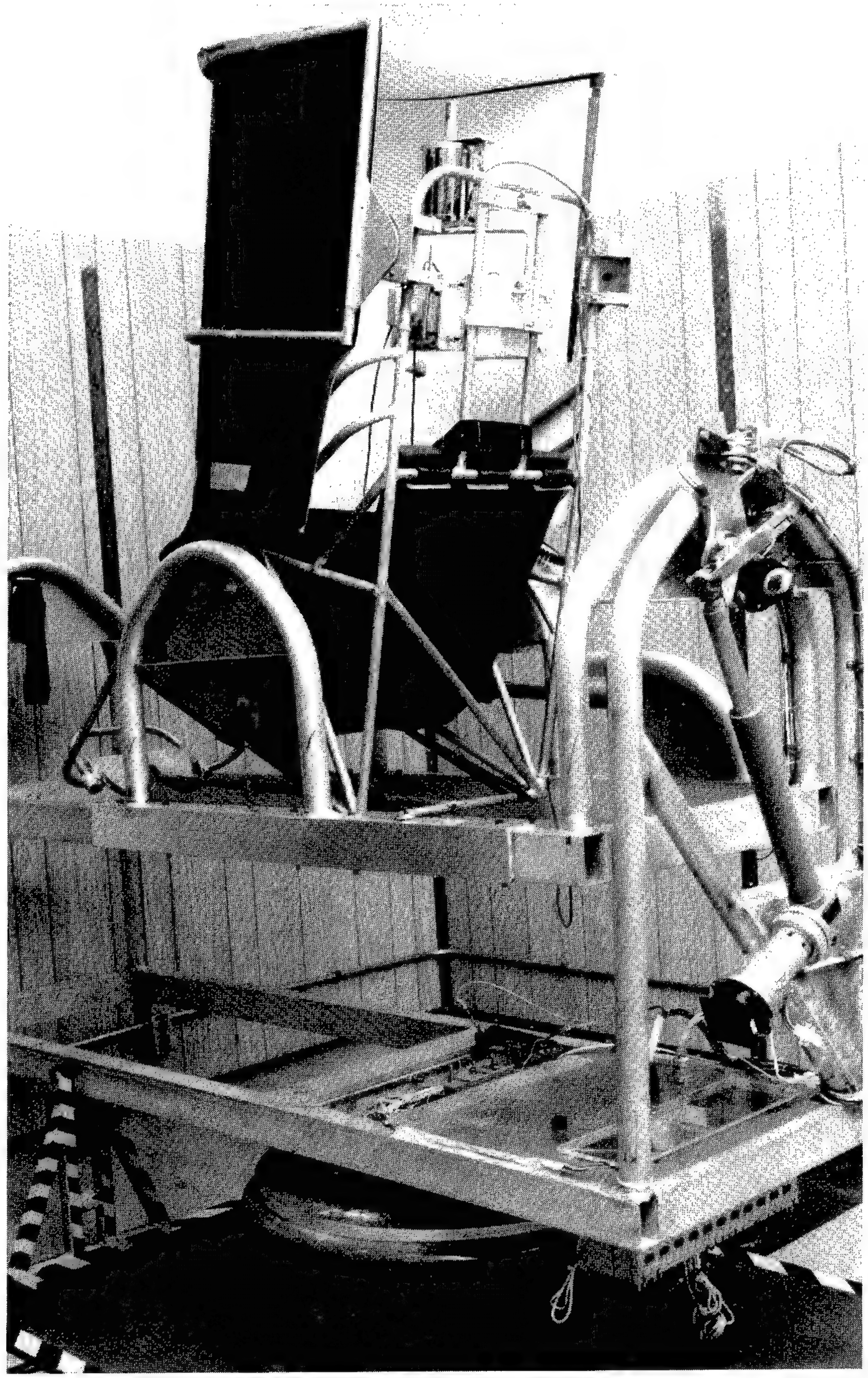
David Matson

The Naval Biodynamics Laboratory in New Orleans, Louisiana, conducts biomedical research on the effects of mechanical forces —impact and motion— on sailors and marines while on ships and in aircraft. The protection of these personnel from motion sickness and other adverse motion effects is important because the effects can impair mission performance. While working at the Naval Biodynamics Laboratory, Thomas Dobie, M.D., a visiting scientist from Leeds University, United Kingdom, developed and validated a cognitive-behavioral motion desensitization training program.

A major advantage of non-pharmacological treatments of motion sickness, based on desensitization training, is that they avoid side-effects which can degrade performance. However, traditional desensitization has not worked well for motion sickness for two reasons. First, motion conditions do not easily generalize from one environment to another. Second, susceptible individuals, particularly in career-related situations, have an anxiety overlay which confounds the problem.

Dr. Dobie has developed a non-pharmacological training program which works better than traditional desensitization training. This training program combines cognitive training to deal with anxiety and behavioral desensitization to motion. The program has already returned pilots to active duty who were thought to be permanently grounded due to chronic motion sickness.

The cognitive training is directed at reducing anxiety in motion environments. This is done in the context of a behavioral program of controlled exposures to increasingly provocative motion conditions in the motion-desensitization chair (see figure). Dr. Dobie's experiences with RAF pilots, high achievers with high performance



Motion-desensitization chair developed at the Naval Biodynamics Laboratory.

anxiety, convinced Dr. Dobie that anxiety is the factor that lowers a person's normal threshold for motion sickness by sensitizing them to the early onset of symptoms.

Controlled motion exposures are produced by a three-axis tilt-rotation chair. Designed and built at the Naval Biodynamics Laboratory, the chair can tilt independently in the roll and pitch axes while rotating up to 20 revolutions per minute. In addition, a semicircular fiberglass shell can be placed in front of the subject. Independent of chair movements, rotating vertical lines can be projected on the shell interior to produce visual sensations of rotation.

This training program is intended primarily as an intervention for fleet or aviation personnel identified as having a chronic problem with motion sickness. For further information you can contact the author at the Naval Biodynamics Laboratory, P.O. Box 29407, New Orleans, LA 70189-0407 or call (504) 257-3980. ●

David Matson, Ph.D., is a Research Psychologist/Neurophysiologist in the Human Factors Division of the Naval Biodynamics Laboratory and an Adjunct Associate Professor of Psychology at the University of New Orleans, LA.

USASC continued from page 15

on all facets of the Army by providing the "users" information and guidance on hazards and problem areas affecting their day-to-day operations. Three of the customer-focused publications used to disseminate safety information and promote safety awareness are *Flightfax* for aviation, *Countermeasures* for ground, and *Civilian Accident Prevention (CAP) Report* for the Army civilian work force.

Coordination and Interface with DOD and Other Army Agencies/ Groups

The coordination and exchange of information between agencies/ groups is essential, particularly in the system safety and human factors arena. Two such groups in which USASC participates are the DOD Human Factors Engineering Technical Group (DOD HFE TG) and the Army MANPRINT Practitioner's Forum. The first System Safety and Health Hazards Subgroup was established within the DOD HFE TG this year. A USASC representative is a current co-chair.

Summary

The Army Safety Center's human factors efforts are as complex and far reaching as the systems used to support today's Army. The efforts described here demonstrate our commitment to safety and human systems integration in life-cycle support of Army systems, personnel, and improvement of combat mission effectiveness.

The views expressed in this article are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

The authors can be contacted at:
Commander
U.S. Army Safety Center
ATTN: Joe Galushka/Dwight Lindsey
Building 4905
Fort Rucker, AL 36362-5363

Commercial: (205) 255-5916/3842
or DSN 558-5916/3842

Joe Galushka and Dwight Lindsey are Engineering Research Psychologists at the Army Safety Center, Ft. Rucker, AL. ●

Position Available

Senior Human Factors Analyst

CSERIAC has an immediate opening for a key analyst in crew system ergonomics/ human factors. Following are some of the preferred qualifications for the position.

- Ph.D. and 15+ years related experience in engineering or psychology with an emphasis on human factors.
- Experience in analyzing problems, finding information, and synthesizing solutions.
- Good communication skills (both written and oral).
- Flexibility and versatility in response to changeable job duties.
- Military experience and/or knowledge of the DoD and government agencies.
- Good interpersonal skills (the ability to interact productively with people in government and industry, as well as coworkers).

For information about CSERIAC, contact Dr. Larry Howell at (513) 255-4842. Send resumes to Robert Artman, University of Dayton Research Institute, Office of Human Resources, Kettering Laboratory 503, Dayton, OH 45469-0105.

Mailing Address

To maintain *Gateway* as a free publication, it is necessary for us to keep the costs down. You can help us do that by making sure we have your correct address and notifying us of duplicate mailings. Also, if you know of anyone who would like to be added to our mailing list, please have them contact us.

Please note the modification to our mailing address.

**CSERIAC Program Office
AL/CFH/CSERIAC Bldg 248
ATTN: Jeffrey A. Landis, Gateway Editor
2255 H Street
Wright-Patterson AFB OH 45433-7022
USA
(513) 255-4842 DSN 785-4842**

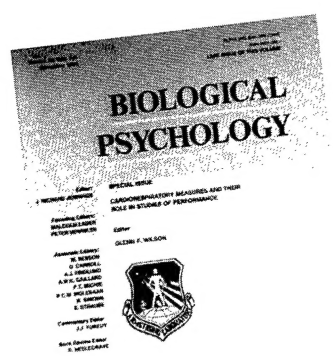
Cardiorespiratory Measures and Their Role in Studies of Performance

Glenn F. Wilson

A special issue of *Biological Psychology* titled "Cardiorespiratory Measures and Their Role in Studies of Performance" has just been published and is available through CSERIAC. The 200-page special issue (shown in the figure) is the result of a workshop held in Dayton, Ohio, the purpose of which was twofold. The first was to bring together experts in the field who represented a broad range of applications and theoretical perspectives concerning the use of cardiac measures in the study of human behavior. The second purpose was to provide a record of recommendations for the use of cardiovascular measures in laboratory and field settings. The special issue fulfills the second goal and CSERIAC will distribute it to provide for maximum distribution of this information among the human factors community. The workshop and special issue are part of a long-term program at the Human Engineering Division of the Armstrong Laboratory. The primary goal is to advance the understanding of human performance using psychophysiological methods, to develop these methods for field use, and to encourage their use in human factors research and practice.

The articles have been written with both the novice and the experienced user of cardiovascular techniques in mind and they are applicable to both laboratory and field environments. Since there are differing opinions regarding areas of application and the proper implementation of cardiac measures, it was felt that a forum which brought together the main theoretical issues, background literature, data collection, and analysis techniques from experts in the area would benefit those who wish to apply these measures or are considering using them.

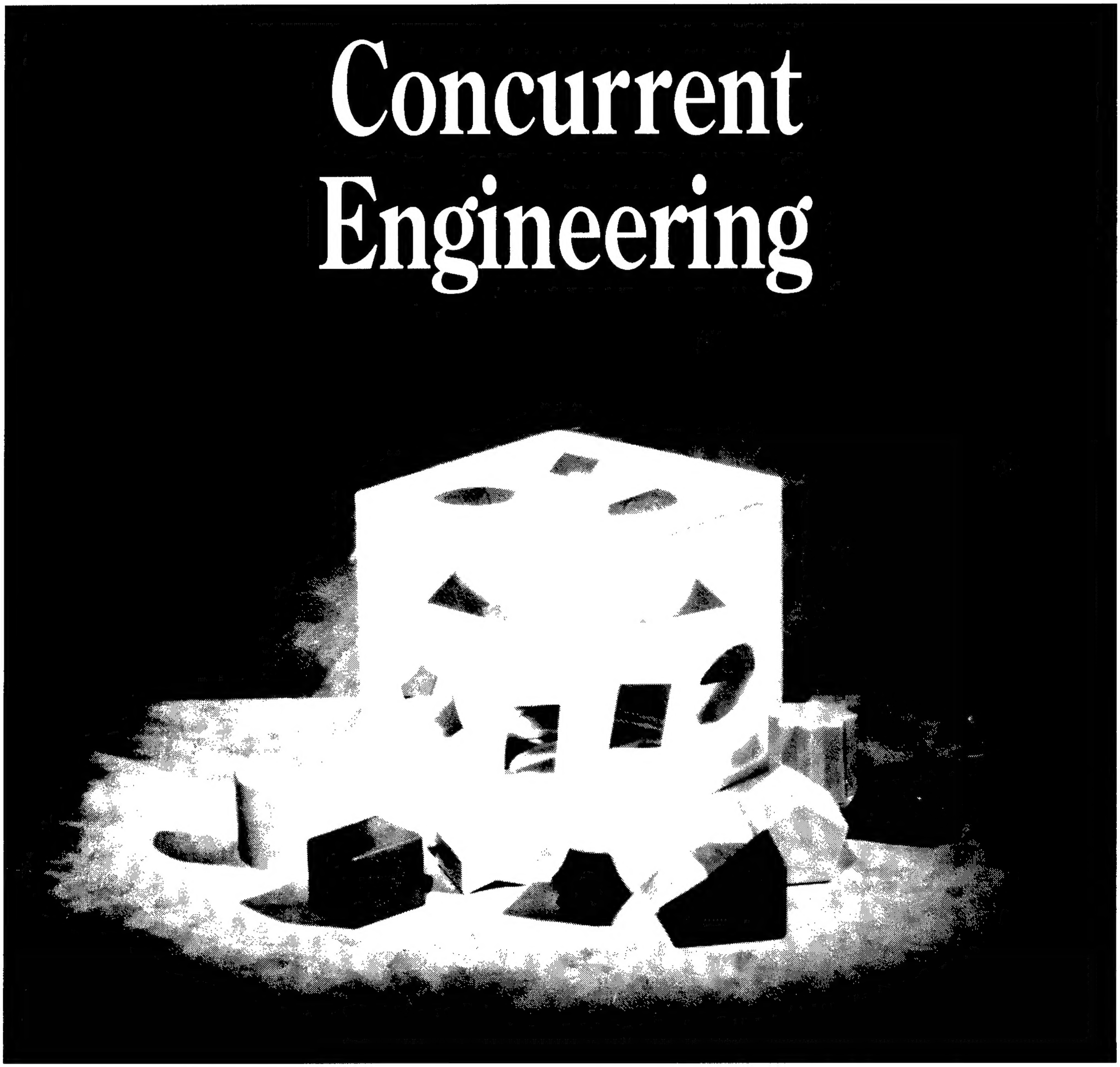
There are seven papers in the special issue. Steve Porges and Evan Byrne of the University of Maryland, wrote "Research methods for measurement of heart rate and respiration," which discusses (a) the physiological and statistical underpinnings of cardiac measures and (b) respiratory sinus arrhythmia. Paul Grossman's article is titled "Respiratory and cardiac rhythms as windows to central and autonomic biobehavioral regulation: Selection of window frames, keeping the panes clean and viewing the neural topography." Paul is at the University of Freiburg and addresses the theoretical and applied issues concerning the use of respiratory sinus arrhythmia as a measure of the effects of cognitive activity and the interaction of respiration and cardiac activity. Glenn Wilson, from the Human Engineering Division of Armstrong Laboratory, addressed using cardiac measures in real-world situations and highlighted possible problem areas when extrapolating from laboratory to applied situations in "Applied use of cardiac and respiratory measures: Practical considerations and precautions." Kees Wientjes' article, "Respiration in psychophysiology: Methods and applications," discusses the literature, data collection and analysis of respiration data. Kees is at the TNO Institute for Perception. Ben Mulder, University of Groningen, used his extensive experience in developing and implementing heart rate and heart rate variability measures to write "Measurement and analysis methods of heart rate and respiration for use in applied environments." Peter Jorna discusses the implementation of heart rate variability measures in applied settings, emphasizing mental workload and stress in "Spectral analysis of heart rate and psychological state: A review of its validity as a workload index." Peter is at the National Aerospace Laboratory in the Netherlands. In the last paper, "Assessing pilot workload. Why measure heart rate, HRV and respiration?" Alan Roscoe explains the use of heart and respiration measures in aviation. His discussion deals with pilot workload and the use of respiration and heart rate to measure workload during flight.



The special issue of Biological Psychology.

This issue brings together the ideas and experiences of scientists from Europe and the United States who are recognized for their expertise in the area of cardio-respiratory measures of human performance. We hope that it will be of value to the human factors community and will encourage the use of these measures in appropriate laboratory and applied settings. This issue of *Biological Psychology* is available through CSERIAC for $25. ●

Glenn F. Wilson, Ph.D., is a Psychophysiologist with the Human Engineering Division, Crew Systems Directorate, Armstrong Laboratory, Wright-Patterson Air Force Base, OH.



Kid Stuff? Hardly...

Imagine trying to put every piece in the proper hole...simultaneously! Well, that's what an integrated engineering approach to complex systems design is like. The parts of this engineering puzzle must be manipulated, information exchanged, and decisions made—quickly. And what about the most expensive element in the system life-cycle cost, the human? Do you have the necessary information to make quick decisions about operators and maintainers? You need fast, accurate, expert advice and tools. We have them.

The Crew System Ergonomics Information Analysis Center (CSERIAC, for short) is your one-stop human factors technology "store." With one phone call, you can have your technical questions answered, customized literature searches carried out, purchase state-of-the-art ergonomics software, or plan a human factors workshop.

Sound interesting? Call (513) 255-4842 today for more information!

CSERIAC: Your Human Factors Technology Store.

CSERIAC Program Office
AL/CFH/CSERIAC Bldg 248
2255 H Street
Wright-Patterson AFB OH 45433-7022
Tel: (513) 255-4842 Fax: (513) 255-4823
DSN: 785-4842 DSN FAX: 785-4823

CSERIAC

ARMY NAVY AIR FORCE NASA FAA NATO

ARMY NAVY AIR FORCE NASA FAA NATO

NEWS FROM the Defense Logistics Agency's

CREW SYSTEM ERGONOMICS INFORMATION ANALYSIS CENTER

- FORENSIC HUMAN FACTORS PSYCHOLOGY - PART 1
- THE COTR SPEAKS
- BOOK REVIEW
- CALENDAR
- LETTERS TO THE EDITOR
- ANNOUNCEMENTS
- AUTOMATION, TAILORING, AND SYSTEM DISASTER
- A CONVERSATION WITH DAVID WOODS
- THE U.S. ARMY SAFETY CENTER AND HUMAN FACTORS
- CHRONIC MOTION SICKNESS
- CARDIORESPIRATORY MEASURES

Bulk Rate
Postage & Fees Paid
Defense Logistics Agency
Permit No. G-53

AL/CFH/CSERIAC BLDG 248 • 2255 H STREET • WRIGHT-PATTERSON AIR FORCE BASE • OHIO 45433-7022
Official Business • Penalty for Private Use $300

CSERIAC PRODUCTS AND SERVICES

CSERIAC's objective is to acquire, analyze, and disseminate timely information on crew system ergonomics (CSE). The domain of CSE includes scientific and technical knowledge and data concerning human characteristics, abilities, limitations, physiological needs, performance, body dimensions, biomechanical dynamics, strength, and tolerances. It also encompasses engineering and design data concerning equipment intended to be used, operated, or controlled by crew members.

CSERIAC's principal products and services include:

- technical advice and assistance;
- customized responses to bibliographic inquiries;
- written reviews and analyses in the form of state-of-the-art reports and technology assessments;
- reference resources such as handbooks and data books.

Within its established scope, CSERIAC also:

- organizes and conducts workshops, conferences, symposia, and short courses;
- manages the transfer of technological products between developers and users;
- performs special studies or tasks.

Services are provided on a cost-recovery basis. An initial inquiry to determine available data can be accommodated at no charge. Special tasks require approval by the Government Technical Manager.

To obtain further information or request services, contact:

CSERIAC Program Office
AL/CFH/CSERIAC Bldg 248
2255 H Street
Wright-Patterson AFB OH 45433-7022

Telephone .... (513) 255-4842
DSN 785-4842
Facsimile .... (513) 255-4823
Government
Technical Manager .... (513) 255-8821

Associate Director: Dr. Lawrence D. Howell; *Government Technical Manager:* Dr. Reuben L. Hann; *Government Technical Director:* Dr. Kenneth R. Boff.

CSERIAC Gateway is published bimonthly and distributed free of charge by the Crew System Ergonomics Information Analysis Center (CSERIAC). *Editor:* Jeffrey A. Landis; *Copy Editor:* R. Anita Cochran; *Editorial Assistant:* L. Brooke Meehan; *Illustrator:* Ronald T. Acklin; *Layout Artist:* Vicky L. Chambers; *Ad Designers:* Fred Niles, Kristen Cheevers.